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Two garnet generations and a load of inclusions: unravelling the complex P–T–t history of a metapelitic gneiss from the south-eastern Moldanubian Superunit, Bohemian Massif

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Garnet–biotite–sillimanite paragneiss from the Loja quarry, next to Ybbs-Persenbeug (Drosendorf nappe) contains two generations of garnet, which can be distinguished based on textural and chemical aspects. Both carry abundant inclusions of major and accessory mineral phases, but also crystallized melt droplets, now observable as nanogranitoids.

The first garnet generation (grt1) forms large porphyroblasts (5–6 mm). It shows remnants of a former prograde growth zoning expressed by a decreasing spessartine content (sps6–sps2) as well as a weak decrease in grossular (grs7–grs5) from core to rim. Crystallized melt inclusions are present in the innermost garnet core next to kyanite, plagioclase, K-feldspar, biotite, rutile, ilmenite and muscovite, indicating peritectic garnet growth at elevated pressure. Zirconium-in-rutile and titanium-in-biotite thermometry combined with GASP barometry and thermodynamic modelling suggest that grt1 started to grow at 1.0–1.2 GPa and 650–700°C. Garnet growth continued towards peak conditions of 1.2–1.4 GPa and 780–820 °C.

The second garnet generation (grt2) is represented by smaller grains (1–2 mm), which occur predominantly around or close to grt1 porphyroblasts, but also as isolated grains in the matrix. The cores of grt2 are relatively calcium-rich (grs15) and carry inclusions of kyanite, staurolite and ilmenite, but no rutile and no melt inclusions. Thus, grt2 started to grow at lower pressure and temperature conditions of 0.6–0.8 GPa and 600–650°C, which indicates the onset of a second metamorphic phase. Towards the rim, calcium is continuously decreasing (grs15–grs6) and the recurrence of rutile as well as microcrystalline melt inclusions next to kyanite indicate a renewed increase of pressure and temperature at supra-solidus conditions. The second garnet-forming event peaked at 1.1–1.3 GPa and 790–830 °C. A subsequent stage of nearly isothermal decompression is recorded by late sillimanite and ilmenite growth in the matrix. After that, the rock experienced final exhumation and cooling.

Th–U–total Pb dating of monazite was applied to monazite inclusions in garnet and to monazite grains in the matrix. Three different generations of monazite were encountered: (1) A first generation of monazite with a pre-Variscan age of 610 $\pm$ 51 Ma is preserved in grt1 and could be a remnant of a Cadomian metamorphic event. (2) Most monazite inclusions in grt1 give Devonian ages of 370 $\pm$ 10 Ma, which is interpreted to represent the age of grt1 and the first Variscan metamorphic phase. (3) Matrix monazites commonly have low-yttrium cores and high-yttrium rims. Both zones give a Visean age of 341 $\pm$ 4 and constrain the age of the second metamorphic phase. The low-yttrium monazite cores formed coeval with grt2, whereas the yttrium-rich rims of matrix monazite grains formed during the subsequent decompression stage.